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TURBO COMPRESSOR SYSTEM FOR FUEL CELL GENERATION
[Nenryo denchi hatsudenyo tabo kompuressa shisutemu]

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Specification /35

1. Name of this Invention

Turbo Compressor System for Fuel Cell Generation

2. Claim(s)

[Claim 1] Turbo compressor system for fuel cell generation in which a compressor is installed in an air supply system path connected to an air pole of a fuel cell, and

the inlet of a modifier and a variable nozzle type turbine is installed in an exhaust system path connected to said air pole and the outlet of the modifier and used for driving said compressor so as to regulate the pressure of the supplied air at an almost fixed level, wherein

the outlet of said compressor and inlet of said turbine are connected through a bypass system path in which a flow quantity regulating valve is installed and arranged to open in the operational area where a less amount of air is supplied to said fuel cell and modifier.

[Claim 2] Turbo compressor system for fuel cell generation in which a compressor is installed in an air supply system path connected to an air pole of a fuel cell and the inlet of a modifier and

a variable nozzle type turbine is installed in an exhaust system path connected to said air pole and the outlet of the modifier and

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used for driving said compressor so as to regulate the pressure of the supplied air at an almost fixed level, wherein

the outlet of said compressor and inlet of said turbine are connected through a bypass system path, and

a flow quantity regulating valve arranged to open in the operational area where a less amount of air is supplied to said fuel cell and modifier and

an assisting furnace for providing heat energy to the air flowing through said bypass system path are installed in said bypass system path.

3. Detailed Explanation of this Invention

(A) [Technological Field]

This invention pertains to a turbo compressor system which is incorporated in a fuel cell generation system and utilized.

(B) [Description of the Prior Art]

A fuel cell generating system can provide heat efficiency higher than a steam power generating system utilizing petroleum, coal, etc. and is better suited for environmental conservation. Therefore, in recent years, various applications utilizing this system were examined not only in the area of specialized power sources for /35[illegible] space development, etc. but also in the area of commercial power sources installed in buildings and the like, and developed increasingly for practical implementation.

The fuel cell power generation system is equipped with a fuel cell having an electrolyte layer interposed between an air pole and a hydrogen pole, a modifier which modifies the hydrocarbon type fuel, such as natural gas, and supplies hydrogen gas to said hydrogen pole as fuel, and an air supply means which supplies air to said air pole and modifier. Moreover, since the capacity of said fuel cell tends to improve as the pressure of each reaction gas increases, the operational pressure of said each reaction gas is set at a value of about 3 - 6 Kg/cm^2 (for example). In this case, air compression requires a large amount of dynamic force, almost reaching an amount which is about 20% of energy generated by the fuel cell. On the other hand, the modifying reaction is provided for creating the fuel gas for the fuel cell at a high temperature at about 800°C, thereby making the modifier discharge the exhaust gas of high temperature. Hence, if the power for compressing air can be acquired from the energy of the exhaust gas of the system, the system efficiency can be significantly improved.

Based on these conditions, the recent fuel cell generating system generally uses a turbo compressor as said air supply means. That is, the turbo compressor is equipped with a compressor interposed within an air supply system path connected to the air pole of said fuel cell and the inlet of the modifier and a turbine interposed within an exhaust system path connected said air pole and the outlet of modifier, and is operated in a manner so that the

supplied air pressure can be almost fixed by this turbine. With this configuration, the energy of said exhaust gas or the like is collected by the turbine and utilized for compressing air so as to improve the system efficiency.

By the way, a relatively small fuel cell power generation system installed individually in a building or the like experiences the significant variation in the demand for power during a certain time period, such as lunch break. Therefore, such system requires an ability of changing the air quantity supplied to a fuel cell and a modifier within a wide range, such as about 25% - 100%. However, on the other hand, there is a demand for high pressure of air supplied to said fuel cell considering the capacity of the abovementioned fuel cell and controlling the fuel cell system. Therefore, by merely applying the regular turbo compressor for compressing the air of the fuel cell, the abovementioned demands cannot be satisfied due to the limitation of the turbo compressor property. That is, for the turbo compressor used in this type of system, the discharge pressure of the compressor must be controlled so as to always provide a fixed value to the discharge pressure by making the nozzle of the turbine modifiable. However, by decreasing the flow quantity while maintaining the discharge pressure of the compressor at a fixed level, the compressor causes surging and makes its operation unstable. In some extreme cases, this instability may cause compressor breakage. That is, when the preset discharge pressure is

high, the operation condition of the compressor easily comes in the area A where surging takes place (shown with oblique lines in Fig. 1), subsequently making it difficult to operate a compressor to provide normal air supply and compression. Therefore, when only a regular compressor is used, it is hard to control the air flow quantity supplied to the fuel cell within a wide range of 25% - 100%.

(C) [Purpose of this Invention]

This invention was developed by focusing the abovementioned situation. Thereby, the purpose of this invention is to provide a turbo compressor system for fuel cell generation which can be effectively used in a fuel cell generation system operated under a wide range of power demands.

(D) [Configuration]

To achieve the abovementioned purpose, this invention provides a turbo compressor system for fuel cell generation in which a compressor is installed in an air supply system path connected to an air pole of a fuel cell and the inlet of a modifier and a variable nozzle type turbine is installed in an exhaust system path connected to said air pole and the outlet of the modifier and used for /35 driving said compressor so as to regulate the pressure of the supplied air at an almost fixed level, wherein the outlet of said compressor and inlet of said turbine are connected through a bypass system path, and a flow quantity regulating valve arranged to open in the operational area where a less amount of air is supplied to said

fuel cell and modifier, or this flow quantity regulating valve and an assisting furnace are installed in said bypass system path.

(E) [Operational Examples]

Hereafter, the operational examples of this invention are explained by referring to figures.

Operational example 1 (Fig. 2):

Fig. 2 is a diagram illustrating the turbo compressor system for fuel cell generation. In the figure, item 1 denotes a fuel cell; item 2 denotes a modifier; and item 3 denotes a turbo compressor. As shown schematically in the figure, the fuel cell 1 is configured by inserting an electrolyte 11 between a hydrogen pole having a hydrogen chamber on one side of porous electrode 4 and an air pole 9 having an air chamber 8 on one side of porous electrode 7, and is design to generate electric power by continuously supplying hydrogen gas used as a fuel to said hydrogen chamber while also supplying compressed air to said air chamber 8. Moreover, the modifier 1 is designed to generate hydrogen gas by modifying hydrocarbon type fuel, such as natural gas, so as to continuously supply this hydrogen gas to the hydrogen pole 6 of said fuel cell 1. With this modifier 1, fuel and compressed air are guided from a guiding port 2a and high temperature exhaust gas is discharged from an exhaust port 2b. Furthermore, the turbo compressor 3 is designed to drive a compressor 12 with a turbine 14 having a variable nozzle 13. In addition, said compressor 12 is interposed in the middle of air supply path 15 making its start

point opened to air and its end point connected to the inlet 8a of air chamber 8 of the fuel cell and the inlet Za of said modifier 2, and moreover, said turbine 14 is interposed in the middle of exhaust path 16 with its starting point connected to the outlet 8b of said air chamber and the outlet 2b of said modifier 2 and also with its ending point opened to air. Moreover, the outlet of said compressor 12 and the inlet of said turbine 14 are connected through a bypass path 17 in which a flow quantity regulating valve 18 is interposed. This flow quantity regulating valve 18 is arranged to open in the operation area where the air quantity supplied to said fuel cell 1 and modifier 2 is small. The opening and closing of this valve 18 is controlled by an actuator (not shown) or the like which is operated using the air flow quantity flowing through said air supply path 15 and rotary speed of said turbo compressor as input signals.

Items 20, 21 are flow quantity regulating valves for adjusting the air supply amount to said fuel cell 1 and said modifier 2.

With this configuration, the turbine 14 is operated by the excessive air at the air pole outlet of the fuel cell 1 and exhaust gas from the modifier 2, subsequently operating the compressor 12. As a result, the air flowing through the air supply path 15 is compressed to the necessary pressure, and continuously supplied to the air chamber of the fuel cell 1 and the modifier 2 to generate electric power. According to this system, by adjusting the opening of the variable nozzle 13 of said turbine 14, the amount of air

supplied to said fuel cell 1 and modifier 2 can be controlled within a certain range, such as about 25% - 100%, while maintaining the pressure of the compressed air ejected from said compressor 12. Therefore, this system can deal with a wide range of power demand changes. Note that, when the operational condition of said compressor 12 enters the surging generating area A shown in Fig. 1 while performing this type of control, the flow quantity regulating valve 18 is opened appropriately. As a result, a part of air ejected from the compressor 12 is guided to the turbine side through the bypass path 17. Subsequently, the flow quantity of the air passing the compressor 12 increases to allow the operation condition to return to the normal operation area B which is the right side of the surge line 1 to effectively prevent the surging occurrence. Therefore, with this type of system, a wide range of changes of electric power demand can be handled effortlessly without causing instability of operation, compressor damage, etc.

Operational example 2 (Fig. 3):

This example uses the same system as described in the Operational example 1 (the parts equal or equivalent to the parts /36 in the operational example 1 are denoted by the same reference symbols and not explained), except that an assisting furnace 22 is formed in the middle of said bypass path 17. This assisting furnace 22 is designed to add heat energy to the air flowing through said

bypass path 17 by burning the fuel continuously supplied from outside.

According to this configuration, since the system not only provides the same operation effect as the abovementioned Operational example 1, but also is capable of supplementing the deficient output of the turbine 14, stable operation can be guaranteed.

That is, when the demand for electric power increases so rapidly that the modifier cannot increase its temperature to accommodate the speed and causes temporary deficiency of turbine power, or when the turbine power always becomes insufficient in a certain operation area due to the characteristic of turbo compressor, fuel is supplied to said assisting furnace 22 so as to add heat energy to the air flowing through the bypass path for supplementing the insufficient power. Thereby, the system can carry out appropriate operation throughout a wide range of operation areas.

Note that needless to say that the method for opening and closing the flow quantity regulating valve of the bypass path is not limited to the abovementioned technique, and therefore, various modification can be made within the scope of this invention.

[Effectiveness of this Invention]

Since the system based on this invention is configured as described above, the air quantity supplied to the compressor is flexibly controlled in a wide range while maintaining the pressure of the compressed air injected from said compressor, problems, such as

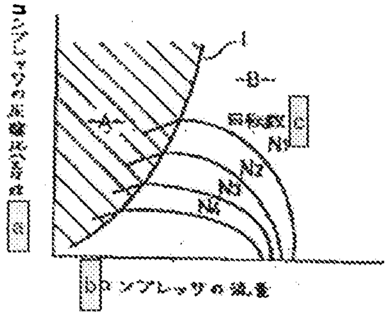
surging, do not occur. Therefore, this invention can provide a turbo compressor system for fuel cell generation which can be effectively used for a fuel cell power generation system operated under the conditions requiring a wide range of power generation changes.

4. Simple Explanation of Figures

Fig. 1 is a diagram for explaining the characteristic of a compressor. Fig. 2 is a diagram for explaining the system of an operational example of this invention. Fig. 3 is a diagram explaining the system of another operational example of this invention.

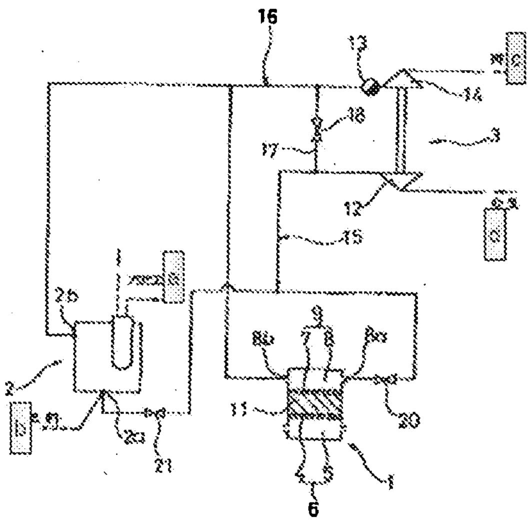
1...Fuel cell; 2...Modifier; 3...Turbo compressor; 9...Air pole; 12...Compressor; 13...Variable nozzle; 14...Turbine; 17...Bypass path; 18...Flow quantity regulating valve; 22...Assisting furnace

Figure 1



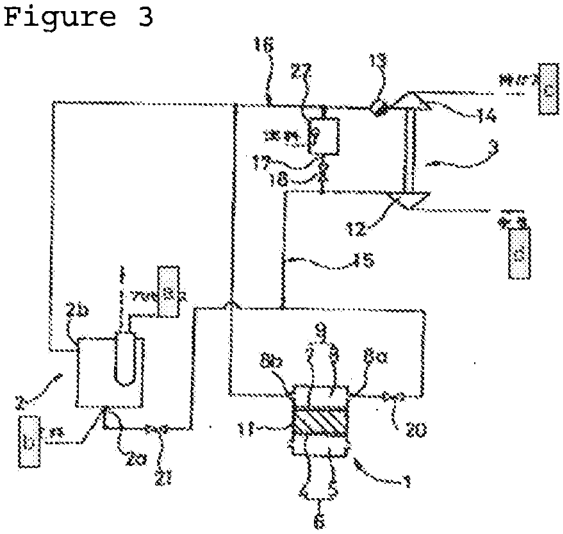
Key:
a) Pressure compression (or discharge pressure) ratio of compressor;
b) Compressor flow quantity;
c) Rotation count

Figure 2



Key:
a) Processing gas;
b) Fuel;
c) Exhaust gas;
d) Air

Figure 3



Key:
a) Processing gas;
b) Fuel;
c) Exhaust gas;
d) Air